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## XI.—*Summary of Zoological Observations made at Naples in the winter of* 1871–72. By E. Ray Lankester, M.A., Fellow and Lecturer of Exeter College, Oxford.

My chief object during a recent stay of some months in Naples was to commence a study of the general and histological development of Mollusca, with the view of ascertaining what significance is to be attributed to the various parts of their organization in the light of the "germ-layer theory," recently extended with such convincing force by the admirable observations of Kowalewsky from the Vertebrata to various groups of lower animals, such as the Vermes and the Insects.

I propose now to give a very short statement of some of these observations, as well as of others made on some of the innumerable interesting forms of marine invertebrates with which the invaluable fishermen of Santa Lucia provided me.

### *Development of* Loligo.

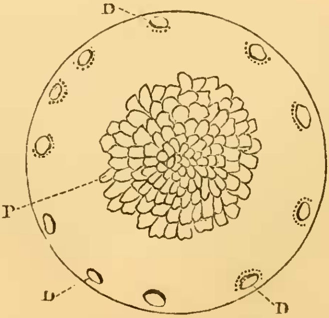
Since the time of Kölliker (1837) no contribution has been made to our knowledge of the development of Cephalopoda. A short note by Mecznikow on *Sepiola* contains very little and is not illustrated. I obtained eggs of *Loligo* first in January, and subsequently with tolerable regularity until April: they are better adapted for observation than those of *Sepia*.

The structure of the ovary is very similar to that of a bird. The branched ovary contains eggs of all sizes enclosed in vascular capsules. The basketwork marking seen on the ovarian egg is not a plication of the proper capsule, but of the surface of the vitellus, *where it is in contact with the inner cellular lining of the capsule*, which sends deeply penetrating ridges and villi into the growing egg. This cellular lining of the capsule grows very rapidly; and its cells are continually being absorbed or fused into the vitellus, whence the increase of this in size. Some of the cells retain their form and are to be found floating in the complex vitellus thus built up.

On attaining full size, the egg, having *lost entirely its large germinal vesicle*, loses all the plications or basketwork of its vitelline surface, and escapes from its capsule, which remains on the branched ovary and undergoes a yellow degeneration. Passing as a free ovoid homogeneous mass of complex yelk (protoplasm and deutoplasm, Van Beneden, combined) into the oviduct, the egg is fertilized; and then at one pole a segregation of plastic yelk, or a germinal patch, occurs in the form of a thin disk or cap. This exhibits subsequently a faint nucleus and commences to divide into two, four, eight, &c. areæ, marked out by intercrossing grooves. In some minor respects my observations differ from Kölliker's, who appears to have represented the segmentation as more regular than it is, and the resulting cells as becoming detached, which they do not.

When this superficial layer of blastodermic cells has spread over an area relatively as large as would be inclosed by the circumference of a half-crown drawn round the pole of a large hen's egg, an exceedingly remarkable fact presents itself, which has not been observed before, and which has great importance in regard to the various theories as to the origin of the "mesoderm," or a portion of that layer. Outside the primitive segmentation-area (fig. 1 P), and quite unconnected with it, appears a ring of very large pellucid nuclei, seven or eight in number (fig. 1 D); they increase in number, and a second, third, and fourth ring of such large nuclei arise, till at last they spread over the whole egg. Meanwhile the cells of the segmentation-area spread by

Fig. 1.



continual division at the free edge of the cap which they form; and *they grow over the large nuclei*, which are thus seen to lie in a lower stratum of yelk than that along which the cap of cells from the primitive segmentation is spreading. Both the segmentation-cells and the large nuclei finally cover-in the whole surface of the egg as two distinct layers. This process I observed over and over again, and repeatedly observed that the large nuclei arise, each one separately, by *segregation from the yelk-mass.* They are products of free-cell formation, and as such of the very highest interest in relation to histogenetic doctrine. The cells which pass into the ovarian egg in such enormous numbers to swell its vitelline mass become so much altered and broken down that it is not possible to regard these large nuclei as descendants from them, though no doubt they, as well as the original egg-cell's protoplasm and the fertilizing male element, have contributed to form an organic "mixture," if one may use the term, from which these free nuclei, as well as the polar segmentation-disk and nucleus, take origin.

The large pellucid nuclei subsequently become branched and stellate; whether they give rise to the whole of the elements of the layer immediately below the outer segmentation-layer it is not possible to say. If they do, contractile muscular cells must be regarded as one of their products. In any case they form the great bulk of the subepidermal tissue, that which corresponds with the mesoderm of vertebrates.

Organs now begin to appear as thickenings on the surface of the blastoderm: two eyes (the details of the primitive development of which are remarkable), two ears (which I repeatedly saw in their primitive state as two pits, holes, or in-pushings of the surface; subsequently they present the condition of capsules, each with a narrow canal opening on the surface of the head, which canal becomes eventually the little ciliated cæcum seen by Kölliker), and a median semicircular primitive mouth; besides these the mantle and arms—the position of the latter marking off the blastodermic sac into two parts, a great yelk-bag, and a smaller embryonic sac, which gradually becomes more and more distinctly pinched off and shaped out. It is not possible to say much of the further development without illustration; but I must mention two very important facts. The primitive semicircular mouth is not the real mouth. It is at this point that an inward cellular growth commences, which eats its way into the mass of homogeneous yelk lying in the embryonic portion of the blastodermic sac, and meets (how or where exactly my observations do not show) a shorter ingrowth from the anal aperture, in connexion with which is also developed the ink-bag, thus agreeing with the renal organ of Gasteropods. The *first portion of the alimentary tube* (which early appears in connexion with the primitive semicircular mouth) *becomes the yelk-duct*. The primitive mouth sinks into the yelk-bag, by the growth of its margins, in a peculiar manner; and there appears at some distance along the primitive alimentary tube *a new mouth*. It seems desirable to speak of these apertures as *primitive* and *secondary* mouth, for the sake of description; but it is a possibility that the *primitive mouth* must be considered identical with the aperture of blastodermic invagination of many Vermes and of *Amphioxus*, discovered by Kowalewsky, and observed also by me in several mollusks (Nudibranchs, *Limax*, *Pisidium*, *Mytilus*).

The second fact of especial interest in the later development of *Loligo* is the occurrence of an in-pushing from the surface in the form of a groove just below (that is, posterior to) the margin of each eye. A somewhat botryoidal mass of tissue is the result of this ingrowth, and gives rise, I believe (though I have not definitely followed out its growth), to the optic ganglion on each side. Lateral masses of tissue are seen to differentiate below the surface on either side of the œsophagus, and extend to the eyes—which may become ultimately other parts of the nervous system. The heart and large vessels develop below the surface, also without any remarkable features. The development of the mantle, gills, and cartilaginous skeleton was accurately described by Kölliker.

The "pen" or shell of *Loligo* develops in a follicle which begins to form at a very early period, and remains open to the surface of the mantle until the embryo is nearly ready to leave the egg-case.

An interesting phenomenon is the contractility of the walls of the yelk-sac, which is observed at a very early period, as soon as the first rudiments of eyes, ears, and mouth have appeared. A rhythmic wave of contraction passes continually along the wall of the sac, at that part immediately in front of the alimentary tube, and doubtless acts so as to cause a circulation of nutrient material in the direction of the young embryo. The tissue which exhibits this contractility is of the same structure (stellate cells) as that of the remarkable contractile vesicle observed in the Pulmonate Gasteropods, and which I have studied in *Limax*. It is probable that the two parts are homogenous.

I should mention that I made frequent examination of eggs of *Sepia*, but found those of *Loligo* the best fitted for study. I was unable to obtain *Argonauta* at Naples; it is to be had in quantity at Messina.

## *Development of* Aplysia.

The development of two species of *Aplysia* was studied in considerable detail as far as the completion of the velum-bearing embryo and its escape from the egg-jelly. Various devices failed of enabling me to observe the later development of this or of several Nudibranchs which were also kept for study.

The *Aplysiæ* were :—a larger species, in which each capsule in the egg-coil contained from thirty to forty embryos ; and a smaller species, in which the number was not more than seven, usually less. The germinal vesicle escapes previously to yelk-cleavage as the "Richtungsbläschen ;" the egg then divides into two larger yellow masses and two smaller pale balls. The pale balls now divide rapidly, and grow over and enclose the larger yellow masses. By a process of multiplication (which I could not satisfy myself was accompanied in *Aplysia* by invagination, though there were indications of such a mode of growth) the pale cells give rise, not to a single layer of cells enclosing the yellow, but, at the pole whence they started, to a considerable mass or thickness of cells. The deeper of these work themselves in between the two large yellow cells and give rise to the alimentary tract ; the outermost cells form epidermis, nerve, and shell-gland, whilst an intermediate portion gives rise to muscles.

In the two species, however, there is a very curious difference: for in the larger species the two yellow cells almost as soon as they are enclosed lose their nuclei and definite outline, becoming mere granular masses, which the deep layer of pale cells rapidly invest and attach to themselves in an intimate manner ; whilst in the small species the two yellow cleavage-masses, each with its large bright nucleus, retain their form to the last (that is, as long as I studied the embryos), the deep pale cells (hypoderm, Darmdrüsenblatt) only passing between the two masses, and growing by absorption of the matter which they yielded, as was evident by their gradual thinning out and shrinking, but without being invested or themselves undergoing any formative changes. The liver-mass, and perhaps the genital glands, subsequently appear in the position occupied by these two big cells, probably growing out *into* them, not from them.

An important fact is the occurrence of cilia on tracts of the pale cells, lying deeply within the segmentation mass ; this I have also seen in the eggs of *Pisidium pusillum*.

The shell-gland is the first organ to appear in *Aplysia*, as it is also in the freshwater Lamellibranch *Pisidium*, and occurs as a groove on the surface, the cells in which take on a special development. It is in this way also that the "cuttle-bone" of *Loligo* takes its origin; and from the observation of this common mode of origin of the shells of Lamellibranchs, Gasteropods, and cuttlefish, I do not doubt that they are fundamentally identical or homogenous—that is to say, have a common ancestral representative. The pharynx and œsophagus early develop in *Aplysia* as in-pushings at the opposite pole to that at which the shell-gland appears, which latter is the pole of active segmentation in the first embryonal changes.

The supraœsophageal ganglion is clearly seen to develop as a thickening of the outer layer of cells in the prostomial region. It sends branches downwards and forwards, and gave rise to the suspicion that the subœsophageal nervous mass was but a lobe of it.

Below the mouth, in a blunt process (which is the foot) the pair of otolithic sacs (or otocysts, as M. de Lacaze-Duthiers terms them) appear; I took great pains to ascertain their earliest beginning. *They certainly never communicate with the exterior*; they have been erroneously supposed to do so in Gasteropoda; and I have established the fact that they really do so in Cephalopoda. The first appearance of each otocyst is, before any organs except the shell-gland are indicated, as a faint vesicle, with no proper walls of its own, just below the most superficial layer of cells; and I believe that it really belongs to that layer. As the foot develops, the otocyst shifts greatly its position, and acquires thicker walls and larger size. The otolith develops within the cyst at a late period; often it may be seen in one cyst and not in the other.

### *Development of Nudibranchs.*

The eggs of species of *Doris*, of *Tethys*, *Pleurobranchus*, and others were frequently studied. I found those of *Polycera quadrilineata* and of *Eolis exigua* the most favourable for study. I was able to determine in these that the first step in development, after the formation by cleavage of the mass of embryo-cells or "polyblast," is the invagination or in-pushing of these cells at one pole, just as Kowalewsky has drawn it in *Amphioxus* and *Phallusia*, and as seen also in the Heteropod mollusk *Atalanta*. The orifice of invagination is at one time large and obvious enough, but closes entirely at a very early period. The same invagination and orifice I have made out in the Lamellibranch *Pisidium*, the development of which I studied in the spring of 1871 at Jena. I also observed it in *Limax*; and its occurrence in a similar stage in certain marine Lamellibranchs is clear from Lovén's admirable figures, though he has mistaken its significance.

Hence the two primitive layers of cells in the embryo mollusk have the same origin as in Vermes and Vertebrata; and, indeed, it would appear that the whole animal series above the Protozoa agree in possessing these two primitive layers at one time of their development. The addition to these of a third, intermediate layer, or mesoderm, is the distinguishing feature of another great branch or stem (Triploblastica), which has as its base the Vermes, and from which diverge the Mollusks, the Arthropods, the Vertebrates, the Echinoderms. That branch which retains but two layers of cells through life, the endoderm and ectoderm, includes the corals, polyps, and sponges (Diploblastica). So far biologists seem to have arrived at very promising results with the germ-layer theory. The great difficulty at present lies in the question, Whence does this third layer, or mesoderm, originate? There are a number of conflicting replies to this question, which have yet to be reconciled.

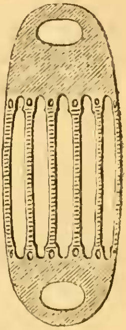
### *Development of* Terebella nebulosa.

An abundant supply of the eggs of this annelid enabled me to follow its development as far as its opacity permits. A delicate chorion forms round the egg after segmentation, on the surface of the cleavage-cells, which are densely ciliated. I observed that the chorion could be caused to separate from the surface of the cells; and the cilia were then seen to be really processes of the protoplasm of the cells, and to *perforate* this cuticular exudation, since they did not break off with it, as often happens, but were drawn through it, remaining fixed to the cells. The development of the ciliated tracts, segments, appendages, and tubiparous glands was followed and drawn. The young of this species has no otolithic sac.

### *Young* Appendicularia furcata.

Numerous specimens of this most interesting form were obtained in February. The recent memoir of Foll has given very full and accurate information on the anatomy of the *Appendicularia*. I have still, however, something to add in this case with regard to the cutaneous glands and the cellular outgrowths of the integument, and as to the heart. It is curious that no one has yet drawn attention to the very remarkable fact that the heart in *A. furcata* consists of but two cells—that is to say, two nucleated histological units. The small number of histological units which build up the organs of an *Appendicularia* is a very noticeable fact, and is parallelled in the case of the Rotifera. The elaboration, however, of so important an organ as the heart from but two units is quite unexampled.

Fig. 2.



The heart as known and described is an oval pellucid body, with a dense mass at each pole. During life it beats with marvellous rapidity, quite unlike the action of a heart, and suggesting (what I believe it is) a form of protoplasmic movement allied to the ciliary. The mass at each pole of the oval heart is seen in specimens about two thirds grown, when dilute acid is added, to be a nucleated cell. From each of these extends, not a contractile membrane (as would appear from the figures of Gegenbaur, Foll, and others), but from twelve to twenty fine processes or filaments joining one cell to the other, leaving open spaces between them. The rapid contractions of these processes of the cells, which are not unlike (except in being fixed at both ends) those processes known as cilia, agitate the blood in which the heart is suspended; but there is no trace of blood-vessels connected with the heart. In specimens of *Appendicularia furcata* of full size the heart was seen to be a little more complex in structure; for at the base of each fibre or process of the two original large conical cells (which still retain their form and their large nuclei) is developed a small swelling with a nucleus (fig. 2). Moreover each of the fibres is now seen (when treated with picric acid) to possess a transverse striation, like that of the muscular fibres of the great tail or flabellum. I have specimens of *Appendicularia furcata*, treated with picric acid and mounted in glycerine, which exhibit admirably at the present moment this very remarkable structure of the heart.

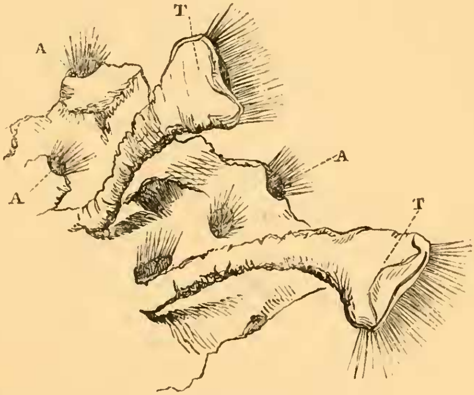
### *Histology of* Sipunculus nudus.

Every naturalist who visits Naples studies this very interesting and abundant worm more or less, and comes to a conclusion respecting its generative organs differing from those of his predecessors. I can only briefly state on the present occasion the results of my study of this worm, as to the histology of which I have a mass of drawings and preparations.

First, as to the corpuscles of the perivisceral fluid. These are the pink corpuscles, the amœboid, the mulberry corpuscles of various sizes (usually regarded as testicular cell-masses), the ova, and the detached portions of the peritoneal membrane, and the "Töpfchen" or ciliated globes. These last were especially studied recently by Brandt; he did not ascertain their origin; he is mistaken in his statements as to "ciliæ capitatæ." The cilia of the "Töpfchen" are in no wise peculiar. What he has supposed to be a head or knob on the end of the cilium is *really* nothing but the bending over of the extremity of the cilium under the influence of the dilute acetic acid which he used. I convinced myself time after time that the cilia of the Töpfchen are perfectly normal, by study, with Hartnack's 10 à immersion, of living specimens, and of others treated with osmic acid. By the use of acetic acid I obtained the knob-like appearance which deceived Alexander Brandt.

Further I have found out the source of the "Töpfchen." They are to be observed in great numbers *attached within* the curious pair of tubes or vessels formed by duplicatures of the peritoneal membrane, which lie on each side of the œsophagus, and the connexion of which with the tentacle-crown was so well shown by Brandt in his memoir. They develop as "buttons" on the cellular surface (fig. 3), which is throughout the perivisceral cavity provided in parts with patches of cilia-bearing protoplasm; and then they become detached and swim off into the fluid. The whole history of this beautiful peritoneal tissue and its shedding of elements into the perivisceral fluid is of extreme interest; but I cannot go into it until my drawings can be given. So much for the Töpfchen at present. Next as to the *ova*. These occur of all sizes in the perivisceral liquid; and Brandt appears to have supposed that they take origin in it. Various zoologists have tried to establish this or that structure as the "ovary." Some have assigned this nature to the pair of large brown tubes opening to the exterior, so paradoxical in character. MM. Keferstein and Ehlers mistook the unicellular cutaneous glands and some vagrant ova

Fig. 3.



for the ovaries, which they actually located beneath the skin; this view I must most fully oppose, as a special study of the integument of *Sipunculus* has shown me what structures these authors have mistaken for ova. Others, again, have taken the strange little diverticulum of the intestine placed near the rectum for the ovary, but without offering proof. I have yet a new view. I consider that the "bush-like processes" described by Keferstein and Ehlers as occurring on each side of the rectum are the ovarian villi. These arborescent tufts are outgrowths of the cellular peritoneum and enclose the ova, which become detached when very small ($\frac{1}{2000}$ inch), either in groups or singly, ensheathed in a portion of peritoneum, and proceed to grow to full size in the perivisceral liquid. The proof of this is in the structure of the villi, and in the structure of floating masses of minute ova occasionally to be found in the perivisceral liquid. The ova are detached from the villi probably at certain seasons and as soon as developed; hence I have never found the villi containing unmistakable ova, when attached in place on the rectum.

The *mulberry spheres* are certainly not, as supposed by Brandt, testicular. They have not the structure of such testicular mulberry masses in Annelids; for in these of *Sipunculus* I have made out what Brandt does not describe, viz. a membrane with a distinct nucleus enveloping the aggregated spherules. They, I believe, give rise to the abundant pink corpuscles of the perivisceral fluid, and are, like the "Töpfchen," detached from the tentacular vessels originally. The true testis is still an open question. I found that the curious little diverticulum of the intestine in several specimens examined in March had become greatly dilated, attaining a full inch in length; and it was filled with a creamy fluid in which were a dense mass of motile filaments. It is possible that these were bacterioid parasites, but most unlikely when they recur in eight individuals examined within two days. There were further appearances of the development of these vibratile rods which tended to confirm the notion that the wall of this diverticulum of the intestine becomes the testis. On the other hand the structure of the great brown pair of tubes was very carefully studied; and I found that they develop in their walls innumerable corpuscles which in spring (May) take quite the form of the Mammalian spermatozoon, and abound in immense number in the liquid filling the brown sacs. The balance of evidence is on the whole in favour of the brown tubes being testes. At the same time let me mention that they become much dilated in May, and take into their cavity large quantities of the perivisceral fluid, and with it the floating ova, or the mulberry spheres, if they are present.

I should mention that one fact in favour of regarding the mulberry spheres as testicular is that when they abound the ova appear to be absent, and *vice versâ*. This is only *apparently* the case; for I have found numerous ova (though far less numerous in proportion than elsewhere) in *Sipunculi* in which the mulberry spheres were predominant, and I have noticed young stages of the mulberry spheres present when ova abounded. It should, however, be noticed that all the full-grown *Sipunculi* (some eighty-five in number) which I opened were distinguishable as either "ova-bearing" or "mulberry-sphere-bearing."

Brandt and, in earlier years, Krohn have been the supporters of the view that the mulberry spheres are testicular; but neither of them has seen the development of the component spherules of the spheres into tailed spermatozoa. Brandt states that he found in May, in a *Sipunculus* of the mulberry-sphere kind, tailed spermatozoa floating in the perivisceral fluid. But he admits that such spermatozoon-like bodies are developed in the brown tubes; and he has no evidence whatever to prove that those he found in the perivisceral fluid had not come thence, especially since he obtained the fluid by puncture and might thus have wounded the brown tubes.

I must yet further mention with regard to the pink corpuscles, that I sometimes found them of large size and containing *crystals* —a fact not noticed by Brandt; also in May I noticed cases in which they were all very small, and in which only a few loosely aggregated mulberry spheres and no ova were present. I believe that the reason why mulberry spheres and ova are reciprocally exclusive in the perivisceral fluid is this, that after the expulsion of the ova a renewal of the pink corpuscles is necessary, and accordingly we get this development of mulberry spheres, destined to break up into young pink corpuscles. It is not until the spheres have fully developed and broken up into young pink corpuscles that a new development of ova takes place, by detachment from the rectal arborescent villi. The testis is either the tissue on the intestinal diverticulum or the brown tubes; which of the two, my notes and drawings do not decide.

The termination of nerves in the skin, the cutaneous glands, the minute structure of the nerve-chord, the structure and varieties of connective tissue in various parts of the worm, and the curious pink or red line on the intestinal wall, which is not a vessel, were examined, and will be described and figured on a future occasion.

Brandt's description of the perforate structure of the egg-envelope is perfectly correct.

### *Anatomy of* Sternaspis.

Specimens of this interesting worm were from time to time brought to me by the fishermen. Its structure presents no special points of contact with the Gephyrea, but rather with the capitibranchiate polychætous Annelids, such as *Pherusia*, which certainly approach the Gephyrea in the condition of their segment-organs. The closed vascular system contains hæmoglobin in solution, and presents an internal series of gills, the structure of which is remarkable in many ways. It would be difficult to make any account of the details of its organization intelligible in this brief summary without illustration.

### *Notochordal rudiments in* Glycera.

The observations of Claparède on the "drei riesige Röhrenfaden" lying above the nerve-cord in *Lumbricus* induced me to search, by means of transparent transverse sections, for evidences of a skeletal or supporting arrangement of the connective tissue in immediate relation with the nerve-cord in other Annelids. The disposition of the muscles in relation to the sheath of the nerve-cord in *Glycera* has some interest in this respect, since these parts are seen, in suitably prepared sections, to have generally the same relations as have the muscles and neural sheath, including the notochord, of a vertebrate.

### *Terebratula vitrea.*

These most beautiful Brachiopods were sometimes brought in quantities by the deep-sea fishermen. I was not able to obtain the ova in a developing condition.

There are still many points in doubt with regard to the Brachiopoda, and especially as to the Terebratulidæ.

This species has not, I believe, been studied in the living state. A young specimen, of the size of a pin's head, exhibited the "arms" in a condition corresponding in general characters with the lophophore of a Polyzoon, with which Mr. Morse's researches on *Terebratulina* also render it clear that the Brachiopod arms are homologous (homogenous). Let me also say here that a comparative study of the structure of the adult arms of *Terebratula* and of the gill-lamellæ of Lamellibranchs leads to the conclusion that these are also homologous (homogenous) structures.

The observations of Mr. Barrett on *Terebratulina*, and of M. de Lacaze-Duthiers on *Thecidium*, are the only ones at present, I believe, as to the condition of the "arms" of Terebratulidæ in the living state.

The cirri are finely ciliated externally; they are also individually movable, though rarely moved. Each cirrus corresponds in essential structure as to its tubular character, its horny and calcareous skeleton, and the circulation within it of the blood, with a tube of certain Lamellibranchs' gills. In young *Pisidium pusillum* the gills originate as three (increasing in number) pairs of tubular processes. In young *Anomia* they equally retain their character as a series of isolated tubules ciliated on the surface. In young *Terebratula vitrea* I found nine pairs of tubular tentacles (wonderfully like the tentacles of a *Pedicellina*) ; and in the adult we have an immense series of them, which only require to become adherent in order to give the essential structure of the Lamellibranch's gill-plate.

The blindness in relation to the intestine of *Terebratula vitrea* is certainly in that Brachiopod's rectum. There is no anus, but a blunt cæcal termination.

I entirely failed to convince myself that the organ regarded by Mr. Hancock as a heart really has the function of one in *T. vitrea*. I repeatedly opened fresh specimens with rapidity, in order to witness its contractions, if any, but never saw such contractions ; nor could I find vessels in connexion with it, nor evidence that it had muscular walls. Dr. Krohn, of Bonn, had equally been unable to obtain evidence that this curious little dilatation has the function of a heart.

The "segment-organs" or oviducts (hearts of Owen) presented a beautiful appearance in the living state, on account of their ciliation. It was possible to preserve them mounted in balsam and also in osmic acid.

The ovaries, lying as they do on the inner surface of the body-wall (which is beautifully marked with calcareous spicula), may be readily studied in various stages of development. The testes are not known at present in any Brachiopod except the diœcious *Thecidium*. The red matter suggested by Hancock as possibly testicular in *Lingula* has its parallel in yellow matter which is abundant amongst the ovarian ova of *Terebratula*. This yellow matter is clearly due to degeneration of the envelopes of escaped ova—is, in fact, a series of *corpora lutea*.

I think it has not yet been clearly pointed out that the ova in Terebratula do not lie freely on the surface of the body-wall ready to drop into the blood-sinus (perivisceral cavity), into which the oviduct opens. Each ovum has really a very delicate connective-tissue envelope; and it is only upon bursting through that that it can escape. Sometimes the ovaries (in December) contain comparatively large eggs, which are readily detached. In the spring, on the other hand, I found most with moderate-sized ova, but some with no ova at all. The ovarian tracts in the latter specimens were obvious enough, since they form a reticulate arrangement of ridges, and the *corpora lutea* marked these tracts also; but no cells which were differentiated as ova were present. Some persons have been inclined to regard these specimens as males; but I consider this merely a temporary condition of the ovary. In some ovaries, at intervals, large white spherical masses containing a quantity of small cells were found; these were the most likely indication of testicular organs which I succeeded in finding. The appearances of the ovary in various conditions, and the structure of the mantle (in which I could not identify the numerous layers distinguished in *Waldheimia flavescens* by Mr. Hancock, in his great essay on Brachiopoda), require illustrations for a fuller explanation.

### Phyllirrhoë bucephala *and* Mnestra.

Perhaps the most charming of all the objects which the Naples Bay affords to a zoologist of histological tendencies is the curious little fish-shaped mollusk *Phyllirrhoë*. Its transparency is perfect, at the same time that the tissue-elements present definite outlines. Its anatomy and histology are well enough known from Heinrich Müller's paper. The pulsating heart—lying in the small pericardium which communicates by a long partly ciliated tube (the representative of the organ of Bojanus) with the exterior—is an object of intense interest. It was easy to trace the connexion of the finest nerve-twigs with muscular fibres and with various peculiar corpuscles. Prof. Panceri discovered, whilst I was at Naples, that these corpuscles, as well as the nerve-ganglia, are phosphorescent.

Krohn described, some thirty years ago, a medusoid which presents the remarkable character of being parasitic on *Phyllirrhoë*. I obtained specimens of this, but have no indication of the way in which it becomes attached. The tissue of the medusoid's disk appears to be *fused* at its middle aboral point with the tissues of the *Phyllirrhoë*. It cannot be removed without tearing, and always occurs just below the chin (if the term be allowed) of the *Phyllirrhoë*. I made out (and have drawings of) a circular and four radiating canals, four marginal tentacles, abundance of thread-cells, and a central chamber.

### Pyrosoma, Æginopsis, *and* Cercaria.

Prof. Panceri and his assistants were carrying on their valuable investigations on the embryology and phosphorescence of *Pyrosoma* whilst I was staying at Naples. In December we obtained a good supply of these most interesting Tunicates.

I directed my attention chiefly to the early changes in the vum, but, owing to the interest which the later development also had for me and the impossibility of keeping specimens alive, did not come to definite conclusions. The germinal vesicle seems to disappear; and a cap of blastodermic cells appears at one pole of the egg, somewhat as in *Loligo*. The changes in the mass of the yelk whilst this goes on are remarkable, and lead to the formation of corpuscles, which appear to circulate subsequently in the embryonic blood-system. I can confirm (if confirmation be wanting) Professor Panceri's and Pavesi's description of the heart and mouth of the cyathozooid, and its mode of connexion with the four ascidiozooids. Professor Panceri's recently published figures (Academy of Naples) are excellent. The colonial muscular system described by Panceri (see 'Quart. Journ. Micr. Sci.' Jan. 1873) was also examined; and I repeated the experiments which he had just carried out, leading to the determination of certain granular masses on the sides of the pharynx as the phosphorescent organs of *Pyrosoma*.

*Æginopsis* was found on one occasion in some water taken from the surface. The structure of the arms was not given by Johannes Müller so fully as examination with a no. 10 Hartnack now allows.

*Cercaria echinocerca* was obtained and drawn from examination with the 10 immersion on several occasions. It is remarkable for the flattened seta-like processes of the integument of the tail.

### *The Parasite of the Renal Organ of Cephalopoda.*

*Dicyema sepiæ* and *D. eledonæ* were first described by Kölliker. Claparède afterwards found a species in the *Eledone norvegica*, and referred *Dicyema* to the ciliate Infusoria. Subsequently Guido Wagner described *D. sepiæ* and *D. eledonæ* in more detail than his predecessors.

There is probably no stranger parasite than the *Dicyema*. The renal organ of most *Sepiæ* may be said to be literally made up of these organisms in all stages of growth. They are clearly not Infusoria, but a degraded form of worm, being multicellular in structure. They are, when typically grown, thread-like bodies one third of an inch in length. There is no mouth, but an axial tissue of scattered stellate cells, which is clothed with large epithelial scales: these are at one time all ciliated; but after full growth the cilia only remain about the head. The head is indicated by a knob, on which the epithelial scales are very regularly disposed in two series. It is rare to find a large *Dicyema* with this head well developed—the reason being that the animals are continually dividing transversely, and a complete head with its symmetrically arranged scales never grows at the surface of fission, but only a partially formed ill-shapen head with two or four scales.

In addition to transverse division, *Dicyema* reproduces by two kinds of internally produced embryos, as pointed out by previous writers. One kind is like the long worm-shaped parent; the other is oval, and ciliated at one extremity. No one has succeeded in following out what becomes of this latter "infusorian-like embryo;" but the embryos resembling their parents clearly grow up to the reproductive state within their host's kidney, and are to be seen in all stages.

I have made out, and hope to figure hereafter, the mode of formation of these two kinds of embryos, which differs considerably in the two cases. Each originates from a single nucleated cell, which multiplies. Those cells, however, which grow into infusorian embryos are contained at first in an oval capsule or space, twenty or so together, and escape from this capsule to undergo development in the axial tissue. The worm-like embryos, on the contrary, arise from single cells scattered at intervals in the axial parenchyma, which do not at first present any special characters.

*Dicyemæ* which are developing infusorian embryos do not at the same time develop worm-embryos. No trace of male reproductive organs is to be seen in these organisms. Their structure admits of the most complete investigation, on account of their small size and transparency.

### *New type of Infusoria.*

Among some eggs of *Terebella*, associated with other Infusoria, I found several specimens of an altogether novel type. The general form was oval; above the mouth projected a small cephalic tubercle; round this oral extremity was raised up a large collar or ruffle, which continually opened and shut with a slight spiral twist, and caused the locomotion of the animal, whilst at the same time food was brought into the region of the mouth. This membranous vibratile collar or ruffle may be compared to a blended crown of cilia. It forms one of the rare examples of undulating membranes, similar to that of *Undulina* (parasitic in the frog's blood, 'Quart. Journ. Micr. Sci.' October 1871), where, however, the membrane is in the form of a crest, and not of a collar as here.

There is not a trace of a cilium on any part of this infusorian, the whole work being done by the vibrating collar.

It is obvious that this form cannot be placed in any one of Stein's divisions of ciliate Infusoria, but must stand alone.

### *Gregarina sipunculi.*

I may refer here to a paper in the 'Quart. Journ. Micr. Sci.' October 1872, in which I have described some facts relating to the development of this form, and figured the pseudo-Navicula or spore-form, the Moneran, pseudo-Cercarian, and Gregarina-forms of this parasite.

### *Spectroscopic Observations.*

Numerous observations with the spectroscope on a variety of animal colouring-matters gave the following results.

Hæmoglobin is present in the nerve-cord of *Aphrodite aculeata*, also in its pharyngeal muscular tissue, in muscles of the dorsal fin of *Hippocampus*, in muscles of the pharynx of various mollusks, in corpuscles in the blood of *Solen legumen*, in corpuscles in the perivisceral fluid of *Glycera*, of *Capitella*, of *Phoronis hippocrepia*, and diffused in the perivisceral fluid of *Polia sanguirubra*.

No characterizable absorption-bands could be obtained from the *blue* pigment of *Velella*, from the *blue* pigment of *Salpa democratica*, or from the *red* pigment of other *Salpæ*, from the *red* pigment of the foot of *Cardium* and other Lamellibranchs, or from the *red* pigment of chromatophores of *Loligo* and other red pigments of fish, &c., or from the *madder-pink* pigment of the corpuscles of the perivisceral fluid of *Sipunculus*.

I cannot conclude this summary without pointing out how great an advantage will be gained by zoologists in the station, now nearly ready for work, which my friend Anton Dohrn has erected on so magnificent a scale, by the devotion of his private fortune and much energy and patience. It stands in the Villa Reale, on the sea's edge; and there the naturalist will not have to dispute and bargain with the intelligent but rascally fishermen; all will be managed for him by the *employés* of the station. Further, he will have the use of a splendid library*, he will be able to keep his specimens with ease in the tanks of the station, supplied with streams of sea-water, and will have constantly the means of contemplating, even when he may not wish to study minutely, those exquisite forms which came in hundreds through my hands, but of which I have here said nothing, with which the waters of the bay are teeming.

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* I take this opportunity of asking for contributions of zoological and botanical books or papers to the library of the Naples station. Several publishers in Germany have given valuable works; the Messrs. Engelmann of Leipzig have presented the whole of their biological publications.